TUNA LONGLINING: RESULTS OF A CRUISE TO THE EASTERN TROPICAL PACIFIC OCEAN[1]

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INTRODUCTION

The commercial longline fishing activities of the Japanese in the western Pacific Ocean, and more recently, the equatorial tuna explorations of the Pacific Oceanic Fishery Investigations, United States Fish and Wildlife Service, in the central Pacific region have demonstrated the presence in these areas of deep-living yellowfin tuna (*Neothunnus macropterus* Temminck and Schlegel) and bigeye tuna (*Parathunnus sibi* Temminck and Schlegel) of larger sizes than normally taken at the surface. In waters adjacent to the equator this subsurface distribution of large tunas has been found to exist eastward to 120 degrees west longitude, which is about 1,700 miles west of the presently flourishing eastern Pacific surface tuna fishery. These developments give rise to the question of whether or not there may be present in the region of the latter fishery similar, if not part of the same, stocks of tunas, living at depths which make them unavailable to present live-bait and purse-seine fishing methods. The existence of such deep-living stocks of adult fish bears important implications to the future welfare of the eastern Pacific fishery for tropical tunas.

In order to obtain first-hand information relating to this problem, and at the same time, to learn more about the general oceanic conditions of the region as it may affect the tunas, an expedition sponsored by the California Department of Fish and Game, the Inter-American Tropical Tuna Commission, and the Scripps Institution of Oceanography was conducted from January 23, 1953, to March 18, 1953. The United States Fish and Wildlife Service also participated by providing technical assistance and the loan of certain items of essential gear.

This report summarizes the results of longline fishing and some of the biological findings of the cruise (53-S-1). Evidence is presented to support the belief that in the eastern tropical Pacific region there are large tunas inhabiting depths well below the surface, whose distribution appears to be influenced by features of the oceanic circulation rather than by the presence of land masses.

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ITINERARY

The California Department of Fish and Game survey vessel, N. B. Scofield, departed from Los Angeles Harbor on January 23, 1953, and the first station was occupied eight days later, on January 31 (Figure 1). After working southward across the equator and completing Station No. 9 at 4 degrees 28 minutes south latitude on February 10, the Scofield put in at the Galápagos Islands, to prepare

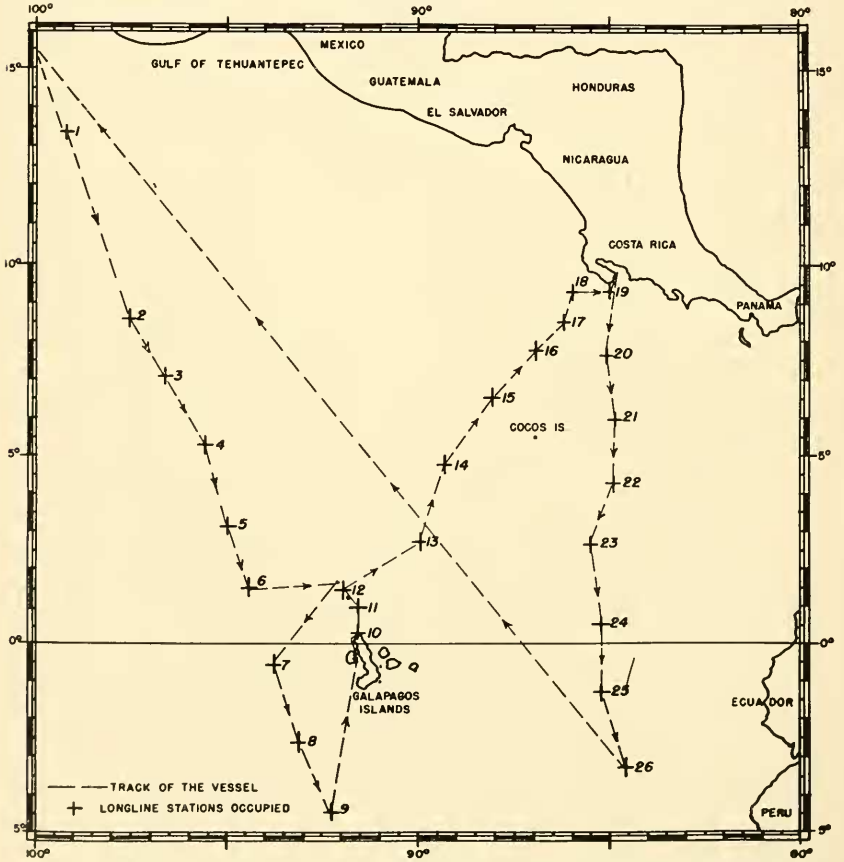

FIGURE 1. M.V. *N. B. Scofield* Cruise 53-S-1, January 23-March 18, 1953.

for the second leg of the cruise. The second leg, a northeasterly track from the Galápagos Islands to the Central American mainland, was begun on February 13. The last station of this leg was completed on February 22, and the vessel entered Puntarenas, Costa Rica, for fuel and provisions. The third and last leg of the cruise was begun on February 26, and the vessel completed the last station off the coast of Ecuador on March 4. The expedition was completed by the arrival of the Scofield in Los Angeles Harbor on March 18.

RESULTS

Longline Fishing

Japanese-style longlines are the only practicable means now known of catching tunas which might be found at below-surface levels in the ocean. For this reason, longlines identical in design and dimension with those used successfully by the Pacific Oceanic Fishery Investigations in their exploratory studies were obtained and employed by the expedition (Figure 2; for a detailed description of these longlines, see: Niska (1953)).

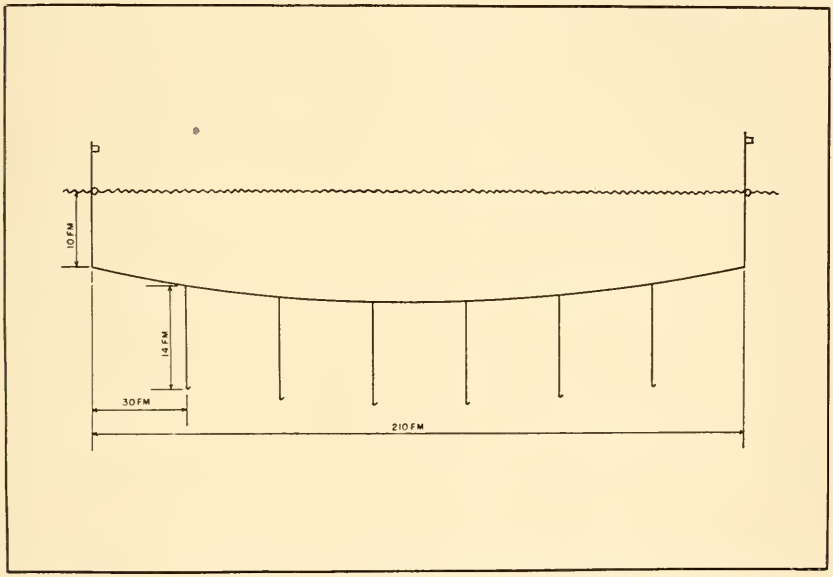

FIGURE 2. One basket; longline gear used by M.V. *N. B. Scofield*, Cruise 53-S-1.

Fishing operations were generally conducted under ideal weather and sea conditions, and it was usually possible to set about 50 six-hook baskets at each station. Most of the gear was set baited with large sardines, obtained and preserved aboard the vessel in a frozen condition, but in some instances the hooks were baited partly with sardines and partly with squid. Both kinds of bait seemed to be equally effective.

At all stations the longlines were laid just after daybreak. Average elapsed time in setting 50 baskets was approximately one hour at a vessel speed of about seven knots. The gear was allowed to "soak" for about six hours before it was brought in. The retrieving operation presented no serious difficulties except in areas of strong current shear, such as around the Galápagos Islands, where the longlines were badly tangled. A high-speed longline hauler of Japanese manufacture was used in retrieving the lines, and the average time required for hauling in a set of 50 baskets was three hours.

A total of 1,180 baskets (7,080 hooks) was fished during the course of the expedition for an average of 45 baskets (270 hooks) per station. A breakdown of the total catch by species and other operational details is given in Table 1.

TABLE 1

M.V. N. B. SCOFIELD, Cruise 53-S-1

Station summary

Station no.	Date 1953	Position	No. baskets fished	Catch by species					Total no. fish
				Yellow-fin	Big-eye	Spear-fishes	Sharks	Others	
1	1-31	13° 20′ N.-99° 10′ W.	30	0	0	5	5	0	10
2	2-2	8° 35′ N.-97° 32′ W.	40	2	0	5	8	1	16
3	2-3	7° 02′ N.-96° 39′ W.	39	2	1	3	9	2	17
4	2-4	5° 12′ N.-95° 36′ W.	50	4	1	3	6	0	14
5	2-5	3° 06′ N.-95° 00′ W.	51	16	4	0	3	1	24
6	2-6	1° 30′ N.-94° 25′ W.	50	9	3	1	6	2	21
7	2-8	0° 36′ S.-93° 44′ W.	50	4	1	0	13	0	18
8	2-9	2° 36′ S.-93° 05′ W.	50	6	2	0	7	1	16
9	2-10	4° 28′ S.-92° 16′ W.	50	19	1	0	4	1	25
10	2-13	0° 15′ N.-91° 20′ W.	50	1	1	0	7	0	9
11	2-14	1° 10′ N.-91° 35′ W.	50	0	0	1	8	1	10
12	2-15	1° 32′ N.-91° 51′ W.	50	0	0	1	8	0	9
13	2-16	2° 47′ N.-89° 57′ W.	50	0	0	0	4	0	4
14	2-17	4° 46′ N.-89° 20′ W.	50	0	0	3	13	3	19
15	2-18	6° 32′ N.-88° 08′ W.	50	0	0	3	30	0	33
16	2-19	7° 48′ N.-86° 56′ W.	50	11	0	8	10	1	30
17	2-20	8° 29′ N.-86° 12′ W.	50	0	0	9	6	0	15
18	2-21	9° 22′ N.-86° 01′ W.	50	2	0	12	2	2	18
19	2-22	9° 20′ N.-85° 00′ W.	50	0	0	13	4	1	18
20	2-26	7° 36′ N.-85° 09′ W.	40	0	0	1	5	0	6
21	2-27	5° 54′ N.-84° 52′ W.	25	0	0	0	32	0	32
22	2-28	4° 14′ N.-84° 55′ W.	31	0	0	4	24	0	28
23	3-1	2° 40′ N.-85° 33′ W.	31	0	1	1	11	0	13
24	3-2	0° 32′ N.-85° 16′ W.	45	0	0	2	6	2	10
25	3-3	1° 18′ S.-85° 15′ W.	49	0	0	1	1	0	2
26	3-4	3° 16′ S.-84° 38′ W.	49	0	1	2	4	0	7
Totals			1,180	76	16	78	236	18	424

Tunas were caught at 11 of the 26 fishing stations. Fishing along the first leg of the station pattern, from Stations No. 1 to No. 9, accounted for 82 percent of all tunas captured by the longlines and this would appear to indicate that deep-swimming large tunas were more concentrated in outlying oceanic waters than in areas close to the American mainland. The most productive zone of tuna fishing was the region adjacent and transverse to the equatorial current system, west of the Galápagos Islands. The catch at stations between 5 degrees north latitude and 4 degees south latitude along the offshore line averaged 4.3 tuna for each 100 hooks fished per day. The best single stations were Nos. 5 and 9, where 6.7 tuna were caught for every 100 hooks fished. No surface signs of fish were observed in areas where these tuna were found to occur. Longline tuna fishing was unproductive on the remaining two legs of the cruise and, contrary to expecta-

tions, the expedition found extremely poor fishing in waters immediately around the Galápagos Islands, which is one of the most productive localities at present for surface tuna fishing.

The catch ratios for all stations by kind of fish were as follows:

Yellowfin tuna	1.1 fish per 100 hooks
Bigeye tuna	0.2
Spearfishes (marlins and sailfish)	1.1
Sharks	3.3
Other	0.3

Although the results of longline fishing may be used to interpret the probable distribution and apparent abundance of deep-dwelling tunas in the eastern tropical Pacific Ocean, it is difficult to assess the true significance of these data because of abnormal oceanic conditions which existed in the equatorial area at the time of the expedition. This anomalous condition, known as "El Niño", is treated in detail under results of oceanographic studies made by the expedition (Wooster and Jennings, 1955).

Tuna Biology

The bigeye and yellowfin tunas that were taken by the longlines were all uniformly large fish. Most of them measured over 1,400 mm. in total length and weighed over 200 pounds. The largest were the bigeye tuna and these weighed upwards of 300 pounds. Figure 3 shows the number of tunas caught and the size range of each species. For purposes of comparison, there is also included a length-frequency distribution of a

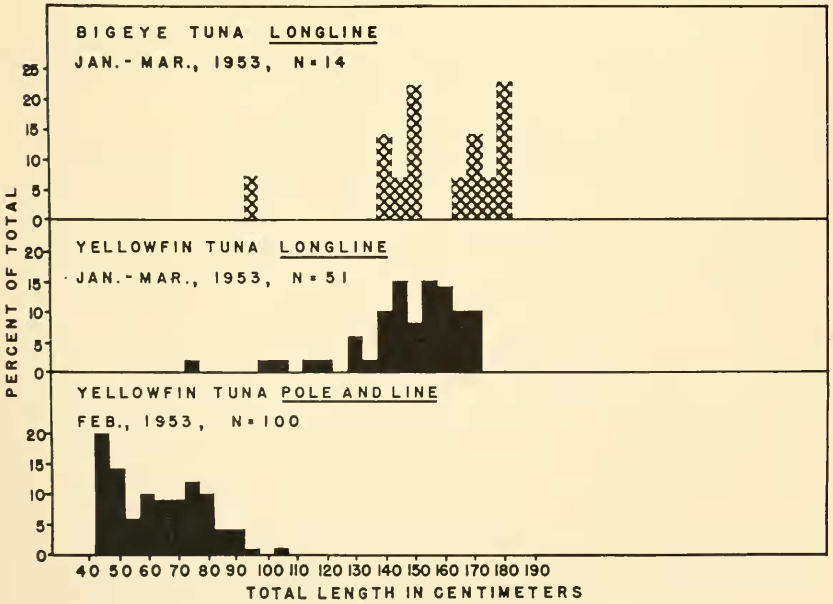

FIGURE 3. Length frequencies of some tropical eastern Pacific tunas.

sample of yellowfin tuna taken from the catch of a tuna clipper which was operating at about the same time and in the same region as the expedition. It is readily apparent that the longlines caught yellowfin tuna of much larger size than those which were taken by pole and line gear. A similar comparison for bigeye tuna is not possible because this species, although occasionally caught by clippers, is not segregated from the yellowfin at the ports of landing. It is believed, however, that in general for bigeye tuna an equal disparity between sizes is to be found for the different types of fishing gear as shown here for yellowfin tuna.

Several of the tunas of both species were examined internally for degree of sexual maturity. Most of the reproductive elements of these fishes, both male and female, were in an advanced ripening stage, and a few individuals possessed ripe gonads. These observations would seem to indicate the onset of a spawning season, and it is not improbable that some spawning takes place during the spring months and possibly at other times of the year in or near the region where these tunas were captured.

Stomachs from as many fish as possible were retained in order to determine their feeding habits. A report on this phase of the biological work is presented as a separate publication (Juhl, 1955).

In addition, samples for racial studies by means of blood typing and paper chromatography were obtained from most of the tunas.

Plankton

The Pacific Oceanic Fishery Investigations have found a meaningful relationship between the occurrence of tunas and the presence of plankton in their studies of the distribution and relative abundance of large tunas in the equatorial central Pacific (Murphy and Shomura, 1953). In order to provide a basis for examining the possibility of a similar correlation between tuna abundance and zooplankton abundance in the eastern Pacific, quantitative plankton hauls were made coincident with longline tuna fishing at each station. These collections were made during daylight hours with a one-meter conical net towed obliquely from a depth of 200 meters to the surface.

Plankton wet volumes were determined for these collections and the results are given in Table 2.

In general, the plankton volumes conform with values obtained previously by the Scripps Institution of Oceanography expedition "Shellback", which was active in the same general region of the eastern tropical Pacific from May to August, 1952. Wet volumes for the longline cruise, however, were higher, on the average, than those from "Shellback" due possibly to a seasonal effect, the two expeditions having been conducted at different times of the year. Collections at the four southernmost stations (Stations Nos. 23-26) on the inshore line from Costa Rica southward may also reflect transient variations in plankton abundance due to "El Niño" conditions. No correlation was apparent between plankton abundance and success of longline fishing.

TABLE 2

Eastern Tropical Pacific Plankton Wet Volumes Corrected to Wet Volumes in Cubic Centimeters Per 1,000 Cubic Meters of Sea Water Strained

Station no.	Position lat.-long.	Date 1953	Start (local time)	End (local time)	Depth meters	Vol. water strained c.m.	Vol. per 1,000 c.m. strained	
							total cc.	sm. org. cc.
1	13° 20′ N.-99° 10′ W.	1–31	0839	0903	127	1274	100	100
2	8° 35′ N.-97° 32′ W.	2–2	0809	0831	159	633	161	161
3	7° 02′ N.-96° 39′ W.	2–3	0840	0855	182	751	93	93
4	5° 12′ N.-95° 36′ W.	2–4	0804	0825	190	733	175	175
5	3° 06′ N.-95° 00′ W.	2–5	0744	0806	199	696	85	85
6	1° 30′ N.-94° 25′ W.	2–6	0809	0831	183	725	119	119
7	0° 36′ S.-93° 44′ W.	2–8	0854	0915	196	677	72	49
8	2° 36′ S.-93° 05′ W.	2–9	0753	0815	203	666	114	114
9	4° 28′ S.-92° 16′ W.	2–10	0753	0816	191	671	167	92
10	0° 15′ N.-91° 20′ W.	2–13	0823	0846	219	685	70	70
11	1° 10′ N.-91° 35′ W.	2–14	0738	0801	208	647	117	117
12	1° 32′ N.-91° 51′ W.	2–15	0744	0816	213	661	159	159
13	2° 47′ N.-89° 57′ W.	2–16	0739	0801	203	674	119	119
14	4° 46′ N.-89° 20′ W.	2–17	1023	1046	200	649	142	139
15	6° 32′ N.-88° 08′ W.	2–18	0809	0830	204	698	97	97
16	7° 48′ N.-86° 56′ W.	2–19	0804	0826	205	713	102	102
17	8° 29′ N.-86° 12′ W.	2–20	0809	0831	229	620	85	85
18	9° 22′ N.-86° 01′ W.	2–21	0824	0846	213	676	99	99
19	9° 20′ N.-85° 00′ W.	2–22	0803	0825	203	696	72	72
20	7° 36′ N.-85° 09′ W.	2–26	0744	0805	202	700	96	86
21	5° 54′ N.-84° 52′ W.	2–27	0724	0746	211	682	145	145
22	4° 14′ N.-84° 55′ W.	2–28	0744	0806	191	739	100	100
23	2° 40′ N.-85° 33′ W.	3–1	0739	0801	229	626	110	110
24	0° 32′ N.-85° 16′ W.	3–2	0753	0815	219	667	147	147
25	1° 18′ S.-85° 15′ W.	3–3	0813	0835	205	710	121	121
26	3° 16′ S.-84° 30′ W.	3–4	0754	0815	201	663	202	202

ACKNOWLEDGMENTS

Acknowledgment is made of the fine cooperation received from the various field units of the United States Fish and Wildlife Service. In particular, we wish to recognize the assistance provided by the Pacific Oceanic Fishery Investigations and the services of their expert longline fisherman, Mr. Sam Okamura. We are also indebted to the South Pacific Fishery Investigations for their analyses of the collected plankton material.

Lastly, much credit for the success of the expedition must be given to the energetic captain and crew of the N. B. Scofield.

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